Chennakesava Kadapa, PhD, AFHEA, MASME, MIET

CONTACT INFORMATION

Lecturer in Mechanical Engineering, University of Bolton, Bolton BL3 5AB, UK.
E-mail: c.kadapa@bolton.ac.uk, thechenna123@gmail.com
Website: https://chennachaos.github.io/website/
ORCiD: 0000-0001-6092-9047

RESEARCH INTERESTS

Computational Modelling of Complex Multiphysics Dynamical Systems: Solid Mechanics, Fluid Mechanics, Structural Dynamics and Vibrations, Fluid-Structure Interaction, Electro-Magneto-Thermo-Mechanics, Finite Element Analysis, Isogeometric Analysis, Computational Fluid Dynamics, Immersed Boundary Methods, Time integration schemes, High-Performance Computing.

TEACHING INTERESTS

I am interested in teaching Engineering Mathematics, Fluid Mechanics, Solid Mechanics, Dynamics & Vibrations, Numerical methods and Programming for Engineers, Finite Element Analysis, Computational Fluid Dynamics, ANSYS Workbench/Mechanical/Fluent and Research Software Engineering.

EDUCATION

Doctor of Philosophy in Mechanical Engineering **2010 - 2013**
Swansea University, Swansea, United Kingdom.
Dissertation: Mixed Galerkin and Least-Squares formulations for Isogeometric analysis.

Master of Technology in Mechanical Engineering **2006 - 2008**
IIT Kanpur, India.
Dissertation: Bifurcations and chaos in misaligned rotors with bearing clearances.

Bachelor of Technology in Mechanical Engineering **2002 - 2006**
G. Pulla Reddy Engineering College, Kurnool, India.
Dissertation: Simulation-Driven-Design of spur gears using C and ANSYS.

HONOURS AND AWARDS

- 2010 - 2013: Prestigious **Zienkiewicz Scholarship** for PhD from Swansea University, UK.
- 2010: **Six-Sigma** Green-belt certification award for process improvement from GE.
- 2006 - 2008: Scholarship for master's degree in IITs from Ministry of Human Resource Development, Government of India. (**All India Rank 77 (top 1%)** in entrance test in Mechanical Engineering.)
- 2002 - 2006: **Prathibha Merit Scholarship** by the Andhra Pradesh state government, India.

RESEARCH FUNDING

1.) 2013-2017: **£250,000** as the sole researcher in the industrial project funded by Schaeffler Group, Germany.

2.) 2017-2018: **£49,000** as the sole researcher in the project funded by Three Cliffs Geomechanical Analysis Limited, Swansea, United Kingdom.

MEMBERSHIP OF PROFESSIONAL BODIES

- Associate Fellow of the Higher Education Academy (AFHEA)
- Member at-large of the American Society of Mechanical Engineers (ASME) UK Section
- Member of the UK Association for Computational Mechanics (UKACM)
- Member of the Institution of Engineering and Technology (IET)
- Member of the International Association for Computational Mechanics (IACM)
- Member of the European Community on Computational Methods in Applied Sciences (ECCOMAS)

WORK EXPERIENCE

W.1.) **Lecturer in Mechanical Engineering**, University of Bolton, UK. **Since Dec-2020**

- Currently developing two master's level modules: MSE7002 - Advanced Engineering modelling and Analysis and AME7008 - Advanced thermal power and energy systems.

W.2.) **Research Software Engineer**, Swansea University, UK. **Jul-2018 to Nov-2020**

- Designed and delivered a course on **High-Performance Computing with MATLAB** for the research staff at Swansea University.
- Successfully **published two papers on my independent research work** on a novel finite element framework for elastodynamics and wave propagation in incompressible material models.
- Successfully fixed the bugs in the Delft3D source code that limited the number of parallel processors to a maximum of 25. The Energy Safety and Research Institute at Swansea University can now successfully perform large-scale hydrodynamic simulations using **hundreds of processors**.
- Developed the software framework for live CFD simulations on a Raspberry Pi cluster for the public outreach event focussed at promoting STEM subjects at the Swansea Science Festival 2018.

W.3.) **Research Officer**, College of Engineering, Swansea University, UK. **Oct-2013 to Jun-2018**

Project: Coupled flow simulations of large-scale geomechanical models. Oct-2017 to Jun-2018

- **Project funding: £49,000.**
- Parallelised the existing Fortran code for HPC platforms using MPI and PETSc libraries.
- Successfully performed large-scale simulations of models of sizes up to **50 million elements**.
- Implemented and tested my B-bar Bézier quadratic triangular and tetrahedron elements.

Project: Computer modelling of check valves in the VCT system. Oct-2013 to Sept-2017

- **Project funding: £250,000.**
- Developed an innovative numerical formulation and built it into a software tool, developed from scratch, using advanced programming concepts in C++ and various third-party libraries for Matrix Algebra (Eigen and PETSc), Computer Graphics and Visualisation (Boost, CGAL and VTK).
- Parallelised the numerical framework for fluid-structure interaction for HPC platforms and successfully performed large-scale FSI simulations of sizes up to 10 million DOFs.
- Installed the software tool at the industrial collaborator, Schaeffler Technologies, Germany, and trained Schaeffler researchers on using the tool.
- Successfully published the research outputs in seven journal papers and at five conferences.
- Assisted in delivering the master's course on Fluid-Structure Interaction (EGEM07).
- Co-supervised one undergraduate, three masters and two PhD students to successful completion.
- Submitted research grant proposals for Sér Cymru II and EPSRC RSE Fellowships.

W.4.) **Engineer** at General Electric Aviation, Bengaluru, India. **Aug-2008 to Sept-2010**

- Developed 2D and 3D finite element models for the turbine rotor components of GE's CF6, CF34, CFM56 and HF120 engines using Unigraphics, Hypermesh and ANSYS.
- Developed an innovative modelling practice for the finite element analysis of elastic-plastic material models and simulated the assembly process of HF120 engine turbine retainers. Was successful in getting this practice **approved as the best practice by the review board**.

CONTRIBUTIONS TO COMPUTATIONAL MECHANICS

1.) Novel finite element formulation for computational solid mechanics using Bézier elements.

- Independent research contribution.
- Unified formulation for statics, implicit and explicit dynamics, and wave propagation.
- Efficient in dealing with volumetric and shear locking.
- Unstructured triangular and tetrahedral meshes using existing mesh generators.
- Nearly and truly incompressible hyperelastic and elastoplastic materials.

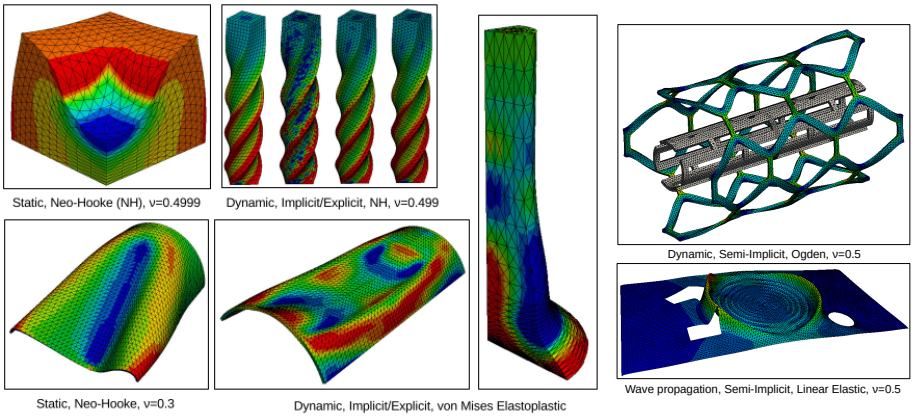

Figure: Simulation capabilities of the proposed finite element framework.

2.) A novel numerical framework for fluid-structure interaction in complex geometries.

- Large structural deformations and solid-solid contact.
- Local refinement capability using hierarchical b-splines.
- Second-order accurate time integration and staggered schemes for computational efficiency.
- Parallelisation for distributed-memory HPC.

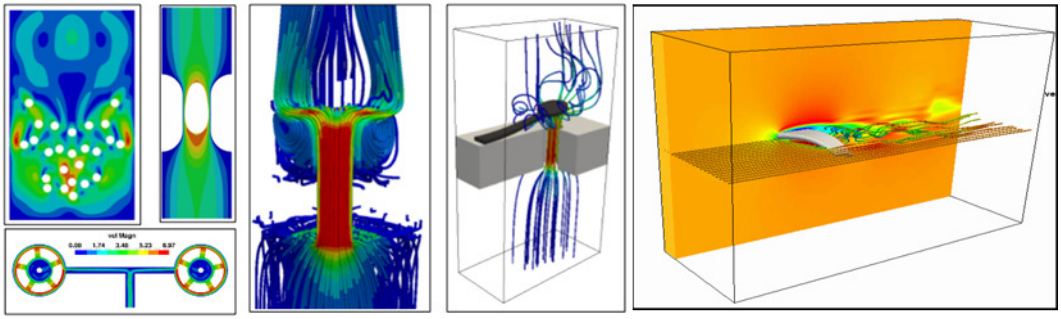

Figure: Snapshots of FSI simulations performed using the FSI tool I have developed.

3.) Mixed Galerkin and least-squares formulations for NURBS based isogeometric analysis.

- Mixed displacement-pressure formulations and LBB-stable combinations.
- Incompressible hyperelastic and elastoplastic material models.

4.) A single-step second-order accurate implicit time integration scheme for structural dynamics.

- Spectrally superior to the widely-used Newmark-β and HHT-α methods.
- Unified time integration scheme for fluid-structure interaction.

TEACHING EXPERIENCE - FULL MODULES

1.) **Fluid Flow (EGF320):**
Fundamentals of fluid flow; internal flows; external flows; fluid kinematics.
`http://engweb.swan.ac.uk/~c.kadapa/teaching.html`

2.) **Advanced Structural Analysis (EGF316):**
Basics of stress and strain; section properties; stresses in cylinders; rotating discs; theories of failure; stress concentration effects; fatigue and linear elastic fracture mechanics.

TEACHING EXPERIENCE - TEACHING ASSISTANT AND WORKSHOP INSTRUCTOR

1.) **High Performance Computing with MATLAB:**
A one-day workshop on high-performance computing using MATLAB's parallel computing toolbox.

2.) **Shell and HPC:** A one-day workshop on Unix Shell and Introduction to High-Performance Computing.

3.) **Software Carpentry:** A two-day workshop on Unix Shell, Programming with Python and Version Control using Git.

4.) **Fluid-Structure Interaction (EGEM07):** Computer modelling for fluid-structure interaction.

5.) **Engineering Analysis I (EG189):** Tutorials on Sets, Functions, Derivatives, Integrals and Matrices.

6.) **Engineering Analysis II (EG190):** Tutorials on Vector Algebra, Complex Numbers, Differential Equations, Multivariate Functions, and Sequences and Series.

7.) **Engineering Design I (EG165) & II (EG263):** Lab on Design principles, Material selection, and SolidWorks.

8.) **Finite Element Method (EG323):** Lab on Programming in MATLAB for basic FEM.

9.) **Computational Plasticity (EGIM08):** Lab on Programming in MATLAB for elastoplastic material models, and ELFEN software.

10.) **Civil Laboratory I (EG107) & II (EG125):** Fluids Lab, Concrete Lab, AutoCAD and SolidWorks.

SUPERVISING EXPERIENCE

Doctorate level:

1.) Alberto Coccarelli, **PhD**, *Modelling fluid-structure interaction phenomenon in human arteries.* Co-supervisors: Prof. Perumal Nithiarasu, Dr. Dimitris Parthimos. **Awarded in 2018**.

2.) Rui Liang, **PhD**, *Simulation of hydrodynamic interaction of flexible fibres in fluid flow.* Co-supervisors: Prof. Wulf G. Dettmer, Prof. Djordje Perić. **Awarded in 2018**.

3.) Hoang Quang, **PhD**, *A computational multiscale approach to the micro-discrete to macro-continuum transition.* Co-supervisors: Prof. Eduardo De Souza Neto, Prof. Wulf G. Dettmer. **Defended in 2020**.

4.) Aleksander Lovrić, **PhD**, *Phase-field modelling for multiphase flows.* Co-supervisors: Prof. Wulf G. Dettmer, Prof. Djordje Perić. **Submitted**.

5.) Mashid Ranjbarestalkhjani, **PhD**, *A Virtual Strategy to Determine Macroscopic Properties of Heterogeneous Composite Materials.* Co-supervisors: Prof. Perić, Prof. Dettmer. **Submitted**.

6.) Peter Hall, **EngD**, *Computer simulation of hydraulic valves in automobile engines.* Co-supervisors: Prof. Wulf G. Dettmer, Prof. Djordje Perić. Year started: 2016. On-going.

Masters level:

1.) Aleksander Lovrić, **MSc**, *On projection-type fractional step methods for incompressible fluid flow*. **Awarded in 2016**.

2.) Leidy Suárez González, **MSc**, *Efficient algorithms for detecting cut-cells and obtaining optimal quadrature points*. **Awarded in 2015**.

3.) Farhad Mani, **MSc**, *Isogeometric least-squares method for impact problems*. **Awarded in 2014**.

Undergraduate level:

1.) Nathan Jones, *Stress analysis of thin-walled aerospace structures using ANSYS*. **Awarded in 2017**.

PEER REVIEWING FOR SCIENTIFIC JOURNALS

1.) Computer Methods in Applied Mechanics and Engineering
2.) International Journal for Numerical Methods in Engineering
3.) Journal of Computational Physics
4.) Computer Physics Communications
5.) Computers and Mathematics with Applications
6.) European Journal of Mechanics - B/Fluids
7.) MDPI journals: Biomimetics, Mathematical and Computational Applications, Fluids, Applied Sciences
8.) Energy Conversion and Management
9.) Engineering Computations
10.) Engineering Structures
11.) Journal of Open Source Software
12.) International Journal of Numerical Analysis and Modeling
13.) Proceedings of the ICE - Engineering and Computational Mechanics

CONTINUOUS PROFESSIONAL DEVELOPMENT

1.) "*Sheffield GPU Hackathon*", 19-23 August, Sheffield, 2019.
2.) "*Dell optimisation training*", 20-21 February, Swansea, 2019.
3.) "*SA2C minisymposium*", 13 September, Swansea, 2018.
4.) "*Fundamentals of Accelerated Computing with CUDA Python*", Cardiff University, July 2019.
5.) "*VI-HPS Tuning Performance Analysis Workshop*", University of Bristol, April 2019.
6.) "*Dirac Day*", Swansea University, September, 2018.
7.) "*Nvidia Hackathon*", Swansea University, September 2018.
8.) "*Data Protection Briefing - GDPR edition*", Swansea University, September 2018.
9.) "*University Teaching*", coursera.org. February 2018.
10.) "*Software testing, Software debugging, and Git & Collaboration*", udacity.com.
11.) "*Web development with HTML/CSS/JavaScript*". Self-learning, January 2017.
12.) "*Parallel programming with OpenMP and OpenMPI*". Self-learning, June 2016.
13.) "*Introduction to Parallel Programming with CUDA*", udacity.com, December 2015.
14.) "*Introduction to Philosophy*", coursera.org, December 2013.

SOFTWARE PROFICIENCY

1.) **Programming languages:** C, C++, Fortran, MATLAB, Python, Bash shell, AWK, HTML/CSS
2.) **High-performance computing:** OpenMP, OpenMPI, Petsc, VTK, Score-P, Scalasca, TAU
3.) **Build tools and KDEs:** GNU Make, CMake, VS Code, KDevelop
4.) **Matrix libraries:** Eigen, PETSc, MUMPS, UMFPACK, SuperLU, PARDISO
5.) **CAD:** AutoCAD, CATIA, Unigraphics, SolidWorks, FreeCAD
6.) **CAE:** HyperMesh, Gmsh, ANSYS
7.) **Visualisation:** Matplotlib, VTK libraries, ParaView

List of publications

Articles Under Review

J.18.) **C. Kadapa**, Z. Li, M. Hossain, J. Wang. *On the advantages of mixed formulation and higher-order elements for computational morphoelasticity.*

Articles Published in Scientific Journals

J.17.) **C. Kadapa**. *A simple extrapolated predictor for overcoming the starting and tracking issues in the arc-length method for nonlinear structural mechanics.* Engineering Structures, 2020. In press.

J.16.) **C. Kadapa.** *A novel semi-implicit scheme for elastodynamics and wave propagation in nearly and truly incompressible solids.* Acta Mechanica, 2020. In press.

J.15.) **C. Kadapa**, M. Hossain. *A robust and computationally efficient finite element framework for coupled electromechanics.* Computer Methods in Applied Mechanics and Engineering, 372:113443, 2020.

J.14.) **C. Kadapa**. *A second-order accurate non-intrusive staggered scheme for fluid-structure interaction with ultra lightweight rigid bodies*. Ocean Engineering, 217:107940, 2020.

J.13.) **C. Kadapa**, W. G. Dettmer, D. Perić. *Accurate iteration-free mixed-stabilised formulations for laminar incompressible Navier-Stokes: Applications to fluid-structure interaction*. Journal of Fluids and Structures, 97:103077, 2020.

J.12.) W. G. Dettmer, A. Lovrić , **C. Kadapa**, D. Perić. *New iterative and staggered solution schemes for incompressible fluidâĂŘstructure interaction based on DirichletâĂŘNeumann coupling.* International Journal for Numerical Methods in Engineering, 2020. DOI: `https://doi.org/10.1002/nme.6494`

J.11.) **C. Kadapa**, M. Hossain. *A linearized consistent mixed displacement-pressure formulation for compressible and incompressible hyperelasticity*. Mechanics of Advanced Materials and Structures, DOI: 10.1080/15376494.2020.1762952.

J.10.) **C. Kadapa.** *Novel quadratic Bézier triangular and tetrahedral elements using existing mesh generators: Extension to nearly incompressible implicit and explicit elastodynamics in finite strains*. International Journal for Numerical Methods in Engineering, 119:75-104, 2019.

J.9.) **C. Kadapa.** *Novel quadratic Bézier triangular and tetrahedral elements using existing mesh generators: Applications to linear nearly incompressible elastostatics and implicit and explicit elastodynamics.* International Journal for Numerical Methods in Engineering, 117:543-573, 2019.

J.8.) A. Lovrić , W. G. Dettmer, **C. Kadapa**, D. Perić. *A new family of projection schemes for the incompressible Navier-Stokes equations with control of high-frequency damping*. Computer Methods in Applied Mechanics and Engineering, 339:160-183, 2018.

J.7.) **C. Kadapa**, W. G. Dettmer, D. Perić. *A stabilised immersed framework on hierarchical b-spline grids for fluid-flexible structure interaction with solid-solid contact*. Computer Methods in Applied Mechanics and Engineering, 335:472-489, 2018.

J.6.) **C. Kadapa**, W. G. Dettmer, D. Perić. *On the advantages of using the first-order generalised-alpha scheme for structural dynamic problems*. Computers and Structures, 193:226-238, 2017.

J.5.) **C. Kadapa**, W. G. Dettmer, D. Perić. *A stabilised immersed boundary method on hierarchical b-spline grids for fluid-rigid body interaction with solid-solid contact*. Computer Methods in Applied Mechanics and Engineering, 318:242-269, 2017.

J.4.) W. G. Dettmer, **C. Kadapa**, D. Perić. *A stabilised immersed boundary method on hierarchical b-spline grids*. Computer Methods in Applied Mechanics and Engineering, 311:415-437, 2016.

J.3.) **C. Kadapa**, W. G. Dettmer, D. Perić. *Subdivision based mixed methods for isogeometric analysis of linear and nonlinear nearly incompressible materials*. Computer Methods in Applied Mechanics and Engineering, 305:241-270, 2016.

J.2.) **C. Kadapa**, W. G. Dettmer, D. Perić. *A fictitious domain/distributed Lagrange multiplier based fluid-structure interaction scheme with hierarchical B-Spline grids*. COMPUTER METHODS IN APPLIED MECHANICS AND ENGINEERING, 301:1-27, 2016.

J.1.) **C. Kadapa**, W. G. Dettmer, D. Perić. *NURBS based Least-Squares Finite Element Methods for Fluid and Solid mechanics*. INTERNATIONAL JOURNAL FOR NUMERICAL METHODS IN ENGINEERING, 101:521-539, 2015.

CONFERENCE PRESENTATIONS

C.11.) **C. Kadapa**. *Simulating complex fluid-structure interaction on supercomputers*, Supercomputing Wales Midpoint Conference, Cardiff, January, 2020.

C.10.) **C. Kadapa**. *Novel unified finite element schemes for computational solid mechanics based on Bézier elements*, UK Association for Computational Mechanics 2019 Conference, London, April, 2019.

C.9.) A. Lovrić, W. G. Dettmer, D. Perić, **C. Kadapa**. *Phase-field modelling*, IGA 2018: Integrating Design and Analysis, Texas, USA, October 2018.

C.8.) D. Perić, W. G. Dettmer, **C. Kadapa**. *Embedded interface methods for fluid-structure interaction: Algorithms and Applications*, 6th European Conference on Computational Mechanics (ECCM 6), 7th European Conference on Computational Fluid Dynamics (ECFD 7), Glasgow, UK, June 2018.

C.7.) **C. Kadapa**, W. G. Dettmer, D. Perić. *A robust stabilised immersed finite element framework for complex fluid-structure interaction*, 19th International Conference on Finite Elements in Flow Problems, Rome, Italy, April 2017.

C.6.) **C. Kadapa**, W. G. Dettmer, D. Perić. *CutFEM on hierarchical B-Spline cartesian grids with applications to fluid-structure interaction*, ECCOMAS Congress 2016, Crete Island, Greece, June 2016.

C.5.) **C. Kadapa**, W. G. Dettmer, D. Perić. *Inf-sup Stable Displacement-Pressure Combinations for Isogeometric Analysis of Nearly Incompressible Materials*, III International Conference on Isogeometric Analysis 2015, Trondheim, Norway, June 2015.

C.4.) W. G. Dettmer, **C. Kadapa**, D. Perić. *Formulation and performance study of an immersed boundary method on a hierarchical B-Spline grid*, VI International Conference on Coupled Problems in Science and Engineering, Venice, Italy, May 2015.

C.3.) **C. Kadapa**, W. G. Dettmer, D. Perić. *Fluid-flexible solid interaction with immersed boundary method based on hierarchical B-Spline grid*, VI International Conference on Coupled Problems in Science and Engineering, Venice, Italy, May 2015.

C.2.) **C. Kadapa**, W. G. Dettmer, D. Perić. *Fluid-structure interaction with immersed boundary method based on hierarchical B-Spline based Eulerian grid*, ACME-UK 23rd Conference on Computational Mechanics, Swansea, United Kingdom, April 2015.

C.1.) **C. Kadapa**, W. G. Dettmer, D. Perić. *Mixed Methods for Isogeometric Analysis of Nearly Incompressible Materials*, XII International Conference on Computational Plasticity, Barcelona, September 2013.

INVITED TALKS AND SEMINARS

T.5.) *Computational fluid-structure interaction - Large deformations, added-mass & staggered schemes*, The Mechanics Discussions Lecture Series, 2020.

T.4.) *Challenges in Computational Mechanics of Soft Materials and Smart Polymers*, Swansea Mathematical Sciences - Unplugged, Department of Mathematics, Swansea University, Swansea, October 2019.

T.3.) *Moving away from Lagrange elements - novel unified finite element schemes for computational physics and engineering using Bézier elements*, My Research Talk, Swansea University, Swansea, May 2019.

T.2.) *Novel explicit/semi-implicit schemes for fluid flow problems*, IIT Madras, India, November 2018.

T.1.) *Fluid-structure interaction schemes based on hierarchical B-Spline cartesian grids*, Durham University, Durham, December 2015.